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LAND VALUES AND ENVIRONMENTAL CHARACTERISTICS IN THE RURAL-URBAN FRINGE

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I. INTRODUCTION

The value of a parcel of land in a metropolitan area is generally considered to result from the natural characteristics of the parcel and adjacent land and the accessibility of the parcel to urban activities and services. Theoretical statements of the relationships affecting land value have been developed by a number of writers [e.g., Alonso, Haig, Park], but empirical studies verifying the theorized relationships are relatively few [e.g., Clonts, Czamanski, David, Downing, Wallace]. Reasons for the scarcity of empirical studies include the difficulty of obtaining reliable data on sale price, the great number of variables which appear to affect price, and the difficulty of measuring many of these variables.

The purpose of this study is to analyze the empirical relationship between land values of a sample of properties, on the one hand, and the environmental characteristics of the properties and their accessibilities to urban activities and services, on the other.

Identification of such relationships would be valuable for predicting the effects of proposed plans, since planning proposals typically involve changes to the physical characteristics of areas and changes in the accessibility of a given parcel of land to urban concentrations. Examples of changes in physical characteristics of a parcel and adjoining areas include cutting down of trees and construction of houses and other buildings, construction of access roads, changes in channel, water quality and flow characteristics of streams, and provision of sewers and water mains. Accessibility is more commonly changed by public plans and programs --- either by increased growth of urban centers or by reduced travel time because of transportation facility improvements.

Changes in land values may constitute the most appropriate index for measuring the effects of many public programs. In particular, programs which result in general improvements to environmental quality have generalized and diffused effects. Often it is difficult to identify any direct beneficiaries, since people do not use the services provided in such a way that their use can easily be observed and measured. The benefits from an area whose environmental characteristics have been

enhanced or protected from degradation, however, must be enjoyed in the area or in its neighborhood. Since these environmental effects are valued, it has been theorized that land nearby and accessible to the preserved or enhanced environment will have a higher value than land farther away. [Stevens and Coughlin].

Such an effect can be expected from the purchase of conservation easements to protect water resources, which would prevent development on such land while keeping it in private ownership. The retention of natural amenity in an urbanizing area would generate benefits in addition to the more traditional water resource benefits of avoidance of pollution, siltation, excess flooding, and extended periods of low flow. Estimation of effects on land value is one of the few possible methods for estimating the benefits of retaining amenity, since the public would not be permitted general access to the area under easement, and therefore, direct "users" of the amenity cannot be identified.

The effects of environmental characteristics, and their preservation, upon land values are not immediately evident, since many factors affect land value. Therefore, if these effects are to be identified, it is necessary to design a statistical

model which includes as variables all the major factors which effect land prices. The immediate purpose of this paper is to develop such a model. An ultimate purpose is to provide a tool for estimating the effect of a conservation easement program on land values. With this ultimate purpose in mind, data were gathered on sales of unimproved parcels located in the watershed of the Upper East Branch of the Brandywine Creek in Chester County, Pennsylvania. Extensive plans involving the purchase of conservation easements were developed for this watershed in 1967-68, [Institute for Environmental Studies, et al.] but were not carried out [Keene, Leopold, Thompson]. Therefore, the ultimate purpose of measuring the effect of conservation easements on land values cannot be achieved through this study.

II. THE SAMPLE

The 37-square mile watershed (see Figure 1), from which data on sales of unimproved parcels were gathered, lies about 35 miles from the center of Philadelphia, and about 25 miles from Wilmington. Thus, it is beyond the area of present suburban expansion and only now is beginning to experience the growth of an exurban population. In 1950, the watershed had about 67 persons per square mile; by 1966 the population density had grown to only 100 persons per square mile.

Unimproved (that is, vacant or undeveloped) parcels were studied in order to avoid the difficult problem of estimating and adjusting for the value of buildings and other structures which are found on improved or developed land.

Of the total number of sales recorded, many could not be included in the analysis because they obviously did not reflect market prices. For example, the records indicated a total consideration of $1.00 for many sales. For others it was obvious from the record that the sale was between members of the same family and that the price was abnormally low. Several parcels purchased by the Philadelphia Electric Company were also elimi-

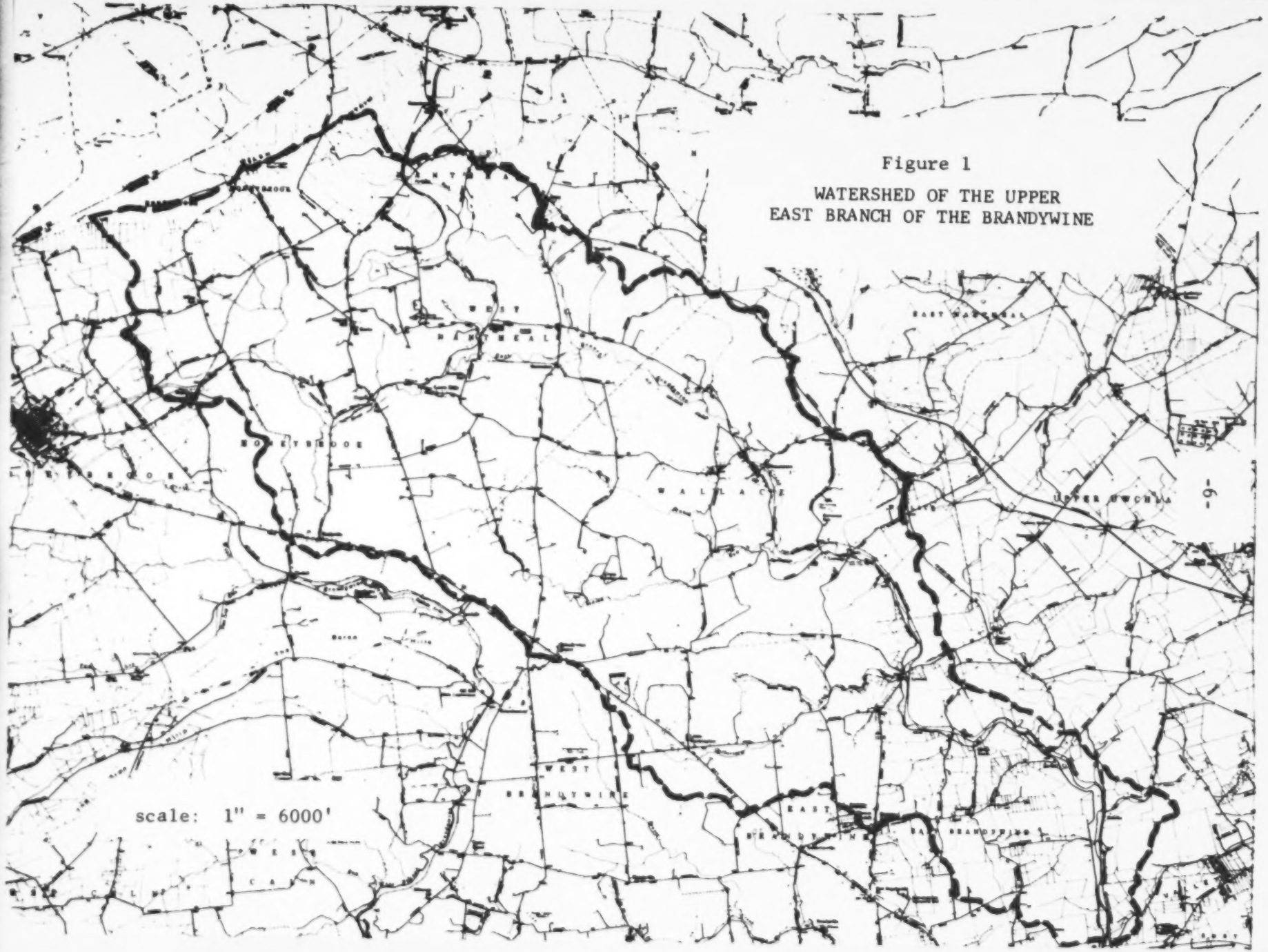

Figure 1

WATERSHED OF THE UPPER
EAST BRANCH OF THE BRANDYWINE

nated from the sample, since these were not purchased under ordinary market conditions. These are the only transactions encountered in which the power of eminent domain was involved, and the prices paid were generally higher than typical for the rest of the sample. A limited number of other transactions had to be eliminated from the analysis because a complete set of data was lacking (e.g., price, size of parcel, or location of parcel was not available).

The resulting sample analyzed consisted of 106 transactions. The locations of the parcels is shown in Figures 2 and 3. The sample is classified by year of sale and parcel size in Table 1.

Figure 2

PARCELS OF LESS THAN 3 ACRES:
LOCATION AND SALE PRICE PER ACRE
1962-1968

Figure 3

PARCELS OF 3 ACRES OR MORE:
LOCATION AND SALE PRICE PER ACRE
1962-1968

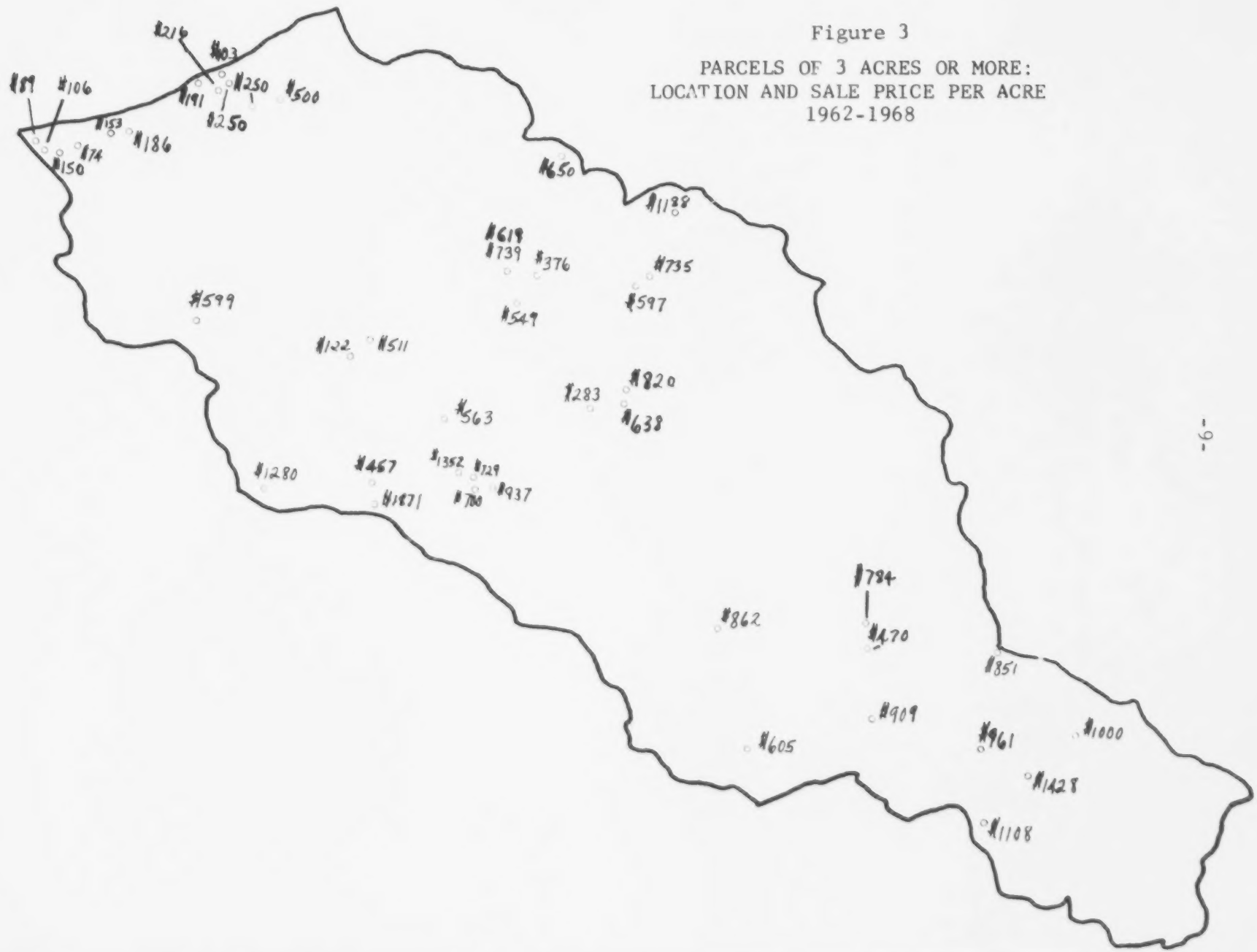

Table 1

CLASSIFICATION OF TRANSACTIONS IN SAMPLE
BY SIZE OF PARCEL AND YEAR OF SALE

	Less than 3 Acres	3 Acres and Over	All
1962	2	5	7
1963	5	1	6
1964	6	1	7
1965	10	7	17
1966	14	12	26
1967	21	11	32
1968	5	6	11
Total	63	43	106

III. THE VARIABLES

The variables measured for each of the parcels are identified in Table 2 and their means and standard deviations are listed in Table 3. The dependent variable is price per acre. The independent variables include those which describe the characteristics of the parcel itself (its size, limitations for sewage disposal, its use, and slope), characteristics of the parcel and its surrounding area (residential density of neighborhood and roughness of land), the accessibility of the parcel to urban activities and services (distance along radial expressway to King of Prussia industrial and shopping center, distance to nearest elementary school, and generalized accessibility to manufacturing employment), and a variable characterizing the township in which each parcel is located (tax rate on market value). The final variable is year of sale. Availability of public water and sewer does not appear because virtually none of the land in the watershed is yet supplied with these services. Zoning classification of the land is not included either, since zoning ordinances were not passed in any of the townships until the latter part of the period for which sales data were collected. In 1968, three townships still did

Table 2

VARIABLES USED IN ANALYSIS OF SALES OF UNDEVELOPED PARCELS

Dependent Variable

X_1 price per acre (data from Chester County Assessor's Office)

Independent Variables

Variables Measuring Characteristics of Parcel

X_2 size of parcel (acres)

X_3 percent of land having only slight or no limitations for on-site sewage disposal

X_4 percent of land having moderate limitations for on-site sewage disposal

X_5 percent of land having severe limitations for on-site sewage disposal

X_6 soils limitation index $2(X_5) + X_4$

(Data for X_3-X_6 from U.S. Soil Conservation Service, Soil Survey-Chester and Delaware Counties, Pennsylvania, 1963).

X_7 percent of land in Flood Plain District (measured from map 27, Plan and Program for the Brandywine).

X_8 percent of land in Stream Buffer District (measured from map 27, Plan and Program for the Brandywine).

X_9 percent of land in Woods and Slopes District (measured from map 27, Plan and Program for the Brandywine).

X_{10} percent of land in forestry and pasture (measured from map prepared by RSRI staff)

Table 2 - Cont.

VARIABLES USED IN ANALYSIS OF SALES OF UNDEVELOPED PARCELS

X_{11} percent of land in farming (measured from map prepared by RSRI staff)

X_{12} percent of parcel wooded (measured from U.S. Geological Survey Map).

X_{13} average slope of land in parcel (horizontal distance for 20' change in elevation; measured from U.S. Geological Survey Map).

X_{14} feet of road frontage per acre (total number of front feet divided by acreage)

X_{15} existence of stream on parcel (0, 1)

X_{16} existence of road frontage on parcel (0, 1)

X_{17} residential density of neighborhood (number of dwellings in 1 square mile square centered on parcel)

X_{18} maximum slope of land in immediate neighborhood (larger of N-S or E-W slope over 2600 feet centered on parcel)

X_{19} roughness of land (standard deviation of 25 elevation measurements equally-spaced over 1 mile square centered on parcel)

X_{20} roughness of land (approximation of surface area of 1 square mile of land centered on parcel).

Variables Measuring Accessibility of Parcel

X_{21} distance to King of Prussia industrial and shopping centers (miles)

X_{22} accessibility to manufacturing employment in surrounding locations weighted by distance squared:

Table 2 - Cont.

VARIABLES USED IN ANALYSIS OF SALES OF UNDEVELOPED PARCELS

$\sum_j \frac{E_j^t}{d_{ij}^2}$ E_j^t = manufacturing employment at location j in year of land sale, t. (Locations are Coatesville, Downingtown, Honey Brook, Pottstown, Phoenixville)

d_{ij} = distance along highways from parcel i to town location j

X_{23} accessibility to manufacturing employment in surrounding locations weighted by distance:

$$\sum_j \frac{E_j^t}{d_{ij}}$$

X_{24} distance to nearest elementary or secondary school (miles)

X_{25} distance to nearest perennial stream

X_{26} distance to nearest major road (route 322 in all cases).

Variable Expressing Characteristic of Township

X_{27} Property tax rate on market value of property. (Source: Table IX, Local Government Financial Statistics, Department of Internal Affairs, Commonwealth of Pennsylvania).

Variable Expressing Date of Sale

X_{28} year of sale (1962 = 1, 1963 = 2, ... 1968 = 7).

Table 3

MEANS AND STANDARD DEVIATIONS OF VARIABLES

Variable & Units		Parcels under 3 Acres		Parcels of 3 Acres or More		All Parcels	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Dependent Variable							
X_1	$/acre	1,287.40	740.33	628.04	416.43	1,019.92	706.26
Independent Variables							
X_2	acres	1.28	0.72	17.77	19.28	7.97	14.67
X_3	%	14.29	34.11	6.16	18.02	10.99	28.86
X_4	%	47.94	45.47	43.58	35.53	46.17	41.60
X_5	%	37.78	42.89	48.05	34.28	41.94	39.77
X_6	index	123.49	62.76	139.67	44.25	130.06	56.32
X_7	%	1.59	12.60	14.09	30.43	6.66	22.41
X_8	%	17.30	35.11	18.77	26.26	17.90	31.69
X_9	%	22.22	40.25	20.47	35.99	21.51	38.41
X_{10}	%	37.30	48.33	55.12	46.39	44.53	48.14
X_{11}	%	31.83	45.83	44.65	46.13	37.03	46.17
X_{12}	%	29.06	44.48	37.44	41.25	32.46	43.20
X_{13}	%	0.748	5.79	9.40	5.37	8.26	5.68
X_{14}	ft/ac.	160.97	193.57	45.09	42.62	113.96	161.62
X_{15}	0,1	0.048	0.215	0.302	0.465	0.151	0.360
X_{16}	0,1	0.778	0.419	0.744	0.441	0.764	0.427
X_{17}	DU/sq.mi	46.65	30.09	23.05	13.36	37.075	27.235
X_{18}	%	3.50	2.02	4.14	2.68	3.76	2.32
X_{19}	ft.	53.30	22.56	69.47	31.47	59.98	27.54
X_{20}	ft.	52,050.27	46.75	52,082.98	65.39	52,063.40	57.16
X_{21}	mi.	27.10	2.82	29.54	4.12	28.09	3.59
X_{22}	empl x d^{-2}	3,202.64	516.90	2,818.13	421.03	3,046.65	514.44
X_{23}	empl x d^{-1}	370.23	236.76	249.28	109.13	321.16	203.53
X_{24}	mi.	2.75	1.45	2.99	1.53	2.85	1.48
X_{25}	ft.	1,119.10	769.27	975.84	971.37	1,060.98	858.21
X_{26}	ft.	8,011.14	5,761.16	13,639.60	7,867.59	10,294.39	7,215.86
X_{27}	mills	1.041	0.655	1.037	0.270	1.040	0.531
X_{28}	1,...7	5.86	1.50	5.77	1.76	5.82	1.60

not have zoning ordinances. Therefore, it was judged that zoning probably was not an important consideration for most sales in the sample.

As can be seen in Table 2, the characteristics are rather general ones and refer to topography, cover, and land use. In addition to scenic amenity, these characteristics also relate to ease of development. Unfortunately, many of the characteristics implying enhanced scenic value (which should enhance sales price) also imply difficulty of development (which should reduce sales price). For example, a parcel which consists largely of flood plain or woods, or has steep slopes is likely to be quite scenic, but it is also likely to be difficult and expensive to develop. Therefore, it is difficult to predict how the market will price such a parcel. As long as major subdividers are not operating in the area, it is possible that the parcel would have a relatively high price because of its scenic quality. But as soon as cost-conscious developers appear, other less scenic but more readily buildable land may bring a relatively higher price.

Although the relevance and measurement of many of the variables are obvious, several require some explanation. Under the first general category, Characteristics of Parcel,

variables X_3, X_4 and X_5 refer to suitability for on-site sewage disposal, which is the only method in use in the watershed; the measurements are adapted directly from detailed maps of the county prepared by the U.S. Soil Conservation Service. The soils limitation index (X_6) is designed to identify all land on which on-site sewage systems may lead to substantial difficulties.

Variables X_7, X_8 and X_9 refer to districts defined in the Plan and Program for the Brandywine for which specific development restrictions were proposed. Land in the Flood Plain District is defined as all land which is flooded on the average of once every 50 years. The Stream Buffer District consists of all land lying within 300 feet of all streams and swales, exclusive of flood plain land. The Woods and Slopes District consists of all land areas of at least 6 acres with slopes of 15 percent or more, and of all wooded areas of at least 10 acres as shown on the Geological Survey maps, exclusive of flood plain and stream buffer land. Generally, land in these three districts is less suitable for development than other land, and therefore one would expect its price to be lower.

Variables X_{12} (percent of land wooded) and X_{13} (average slope of parcel) provide separate measures of the two attributes of the Woods and Slopes District (X_9).

Since the land in the sample of transactions is all undeveloped, its present uses are limited. The only land uses included in the analysis are percent of land in farming, and percent in forestry and pasture (X_{10} and X_{11}).

Under the second general category, Characteristics of Parcel and Adjoining Land, a one-mile square centered on the parcel was used to make measurements of the general neighborhood in which the parcel was located. The number of dwellings within this square mile (X_{17}) were counted from a map of land use as of 1967, which was prepared from air photographs and a field survey. In order to measure general roughness of topography, two alternative measures were used. Each began with 25 equally-spaced measurements of elevation made within the square mile. The first measure (X_{19}) consists of the standard deviation of these 25 elevations, which indicates the dispersion of the distribution of elevations. This measure of dispersion is not entirely suitable, since it does not

provide an indication of the spatial dispersion of these elevations. The second measurement (X_{20}) is a more adequate measure of the spatial dispersion of elevations. It consists of an approximation of the surface area of land over the square mile defined by the 25 locations at which elevations were noted. To compute this measure, five sections were drawn in the N-S direction and five in the E-W direction. The length of the surface edge of each of these sections was computed and all 10 surface-edge lengths summed.

The third category, Accessibility of Parcel consists of a number of distinct accessibilities.

Distance to King of Prussia (X_{12}) is entered as a proxy for distance to downtown Philadelphia, the center of the metropolitan area. The King of Prussia industrial and commercial area is on the radial expressway which connects the Brandywine area to the center of Philadelphia. Therefore, all distances to King of Prussia increased by a constant would give the distance to downtown Philadelphia.

The more generalized accessibility variables (X_{22} and X_{23}) refer to accessibilities to neighboring cities and towns. The

form of the variable is the familiar "gravity" formulation (Carrothers). Manufacturing employment is used to measure "opportunities" at each city. Data on manufacturing employment were used since they were available for each year, whereas data on the more general variable, population, were available only for 1960. Results would probably not differ substantially if population were used, since examination of the 1960 data indicates a strong correlation between manufacturing employment and population. The exponents on distance used in X_{22} and X_{23} are intended to cover the normal range. Distance was measured along roads.

IV. RESULTS

Earlier analysis (Stevens and Coughlin, 1968), as well as discussions with appraisers and general knowledge of the real estate market, has indicated that the market for building lots is distinct from that for large tracts. In general, it is believed that the price per acre for land in large tracts is substantially lower than for land in small building lots. Therefore, before beginning the analysis, the sample of transactions was divided into those for parcels of less than 3 acres and those for parcels of 3 acres or more.

Stepwise regression analysis was carried out both for the subsets of small and large parcels considered individually, and also for the entire set of transactions. The results are summarized in Table 4. The equations and their individual component variables were generally significant at the 0.05 level. All variables appear with the expected sign, with the possible exception of those variables relating to streams (variable 15 for small parcels and variable 25 for large parcels). Given the view that a stream is an amenity, one might hypothesize that the presence of a stream would add to property value. However, for both large and small properties accessibility to a

Table 4

SUMMARY OF REGRESSION RESULTS
(Dependent Variable: Sale Price per Acre)

	Parcels under 3 Acres		Parcels of 3 Acres or More		All Parcels	
Multiple R	.668		.709		.751	
Std. error of estimate	564.76		308.93		477.66	
No. of observations	63		43		106	
Constant Term	834.54		1,884.92		497.06	
Independent Variables	Coef-ficient	t-Statistic	Coef-ficient	t-Statistic	Coef-ficient	t-Statistic
Characteristics of Parcel						
2. Parcel size					-6.46	-1.9
3. % slight limitations for on-site sewage					3.95	2.3
12. % parcel wooded	-5.04	-3.1	-3.05	-2.0	-3.19	-2.7
14. road frontage per acre					0.82	2.6
15. stream on property	-793.18	-2.3				
Characteristics of Neighborhood						
17. residential density	13.66	5.6			14.59	7.57
19. roughness of land			-5.89	-2.4		
Accessibility of Parcel						
21. dist. to King of Prussia			-28.00	-2.1		
26. dist. to nearest stream			0.10	1.4		

stream was found to be associated with lower land values. The reason for this is understandable for small properties: the existence of a stream on a property of less than 3 acres implies that at least a significant proportion, if not all, of the property is in flood plain, marsh, or is steeply sloped. It is less clear why the price of large parcels should be affected adversely by stream accessibility, since even if a stream crossed the parcel, most of the land in the parcel would remain buildable. At any rate, the effect for large parcels is weak and the coefficient fails to attain statistical significance. Neither "stream" variable appears in the equation for large and small parcels combined.

The results for large and small properties indicate that value probably is determined differently for each group. Only one variable --- percent wooded --- appears consistently and significantly for each sub-group and for the entire sample. The stream variables appear consistently, if not always significantly, for the two sub-groups. In addition to these variables, the price per acre of small parcels is characterized by density of residential development in the neighborhood.

Density of residential development in the neighborhood implies the existence of certain urban services in addition to providing neighbors --- especially playmates for a newcomer's children. Therefore, although it is hypothesized that many people move into the Upper East Branch Brandywine area because they are attracted to the natural countryside, the availability of neighbors is also a consideration, especially for those who buy relatively small lots, which are more characteristic of suburban development than of rural development.

For large parcels, a different set of variables came into the regression equation: distance to King of Prussia (which is a proxy for distance to the center of the metropolitan area) and topographic roughness of the neighborhood. Both of these variables can be interpreted as measures of the development potential of the land, and their presence in the regression equation suggests that large tracts are being bought with an eye to their eventual development. An alternative interpretation of topographic roughness is that it is a measure of amenity, rolling or hilly land being more desirable than flat land. However, to be consistent with such an explanation, topographic roughness would have to appear with a positive

sign in the equation.

Although the prices of large and small parcels appear to be determined by different sets of variables, the best overall statistical explanation is achieved when parcels of all sizes are combined. Multiple R increases to .75 at the same time that the sample size is approximately doubled, resulting in a substantial increase in level of significance. In the equation for the combined sample, parcel size appears as an independent variable, reflecting the different market forces acting on large and small parcels. Residential density, which appeared in the equation for small parcels, also appears in the equation for all parcels. In addition, percent of land with slight limitations for on-site sewage, and frontage per acre appear in the combined equation. These variables would have been the next to enter in the stepwise regression analysis of small parcels. However, missing from the combined equations are: topographic roughness, distance to King of Prussia, and distance to nearest stream, all of which appeared in the equation for large properties, and existence of a stream on the parcel, which appeared for small parcels.

In that these variables do not appear in the combined equation, it is less appealing than the equations for subgroups. The lack of distance to King of Prussia, or any other variable expressing accessibility is particularly disappointing. However, there may be reason to believe that differences in accessibility among locations in the Upper East Branch basin would have relatively little effect on price. The basin lies 17 miles from the King of Prussia Interchange and between 30 and 35 miles from the center of Philadelphia, and is well beyond the ring in which subdivision activity is now most intense. At such distances from major activity centers, an additional few miles is likely to have little effect on perceived distance and correspondingly little effect upon land price. Accessibility to nearby medium-sized urban centers (Downingtown, Coatesville, Honey Brook, Phoenixville and Pottstown), which is measured by variables 22 and 23, is quite strongly correlated with distance from King of Prussia.

It is of interest that year of sale did not appear in the regression equation at a significant level. This indicates that the land market in the basin was not affected during the period by rapidly rising land prices, which typically precede

urbanization. This is consistent with our interpretation of the distance-to-King-of-Prussia variable. If the zone of suburban development had reached the inner edge of the basin, one would expect to find a land price gradient dropping sharply with distance from King of Prussia and distance to the center of the metropolitan region.

The most significant independent variable explaining price per acre, is residential density in the neighborhood. It appears at a far higher significance level than does any other variable in the small-parcel sample and in the complete sample. It does not appear, however, in the equation for large parcels, even though its correlation coefficient with price per acre is relatively high (0.496). This is evidently because residential density has a high negative correlation with roughness of land, which did enter the equation.

In summary, the equations for price per acre are statistically adequate, and consistent with the market, locational, and topographic conditions existing in the Upper East Branch Brandywine basin. The variables which appear in the equations should probably be considered in any attempt to construct a statistical model of the land market for any comparable area in

the urban-rural fringe of a metropolitan area. However, in any such investigation it is likely that some of these variables would be found to be not-significant, while other variables, not in our equations, would be found to be significant. The equations derived here should be used as a guide for studies of other areas, but it would be improper to apply the equations as they stand to another area.

Addendum: Environmental Attractiveness and Land Value

The benefits of a land use and water resource plan, such as the Brandywine Plan, consist in part of "scenic" benefits. Following such a plan, certain areas would be selected in which urban development would be prevented. Thus, natural or semi-natural scenery would be retained for public enjoyment, even though the public could not actually enter on and use the land. An approximation of the value of the "scenery" provided by such a parcel of land is desired. Fundamental to an adequate approximation of the value of the "scenery" is the relationship between price per acre and variables which express certain aspects of environmental attractiveness.

In order to identify such relationships a number of "environmental attractiveness" variables were conceptualized and

measured for the 28 properties which were sold in 1967 or 1968 and were still sufficiently undeveloped so that observations could be made in the field which would correspond, at least roughly, to observations which might have been made at the time of sale.

The conceptualization of the variables, which are listed in Table 5, is based on research on environmental perception and preference which was being carried out concurrently with this land value analysis [Rabinowitz]. That research showed that a sample of middle-class suburban housewives preferred areas with a parklike landscape: generally open areas with low ground cover and a relatively small number of relatively large trees. Various aspects of this preferred landscape are measured in variables 1, 2 and 3. The view from a lot is generally considered to contribute to its desirability (variables 4 and 5). The hypothesized effect of the number of houses or mobile homes visible from the parcel (variable 6) is not clear, but our findings in the previous section concerning residential density would indicate a positive effect upon price per acre. However, residential density within sight of a parcel (i.e., variable 6) has only a very weak association with density

Table 5

CORRELATION COEFFICIENTS BETWEEN
AESTHETIC VARIABLES AND SALE PRICE PER ACRE

Aesthetic Variable	Expected Sign	Less than 3 acres	3 Acres & over	All Transactions
1. Average girth of trees	+	-.560		-.322
2. Average height of ground cover (in.)	-	-.538	.343	-.306
3. Percent of area in open space	+	.346	-.615	.092
4. Log of length of longest view (ft.)	+	.028	-.137	-.144
5. Log of average length of view (ft.)	+	.086	-.199	-.134
6. Number of houses or mobile homes visible	-	-.046	.037	-.158
7. Average number of items observed	+	.293	-.201	.228
8. Average attractiveness rating (3 observers)	+	-.577	.171	-.485
Number of Transactions		18	10	28

Note: Correlations significant at the 0.05 level are underlined.

within a one mile square (correlation coefficient of -0.097 for all 28 properties). Therefore, it is reasonable to argue that number of houses visible and number of houses within an accessible distance both have a different functional and perceptual meaning for a prospective land buyer, and are not strongly associated as measures of physical density.

The last two variables listed in Table 5 are both at a somewhat higher level of abstraction and measured less objectively than the earlier variables. The number of different elements or items observed by three field observers provides a measure of the "complexity" of a given landscape.[1] The attractiveness rating (variable 8) is a purely subjective rating (on a 1 to 5 scale) assigned by three observers and averaged.

Comparison of the expected sign of the correlation between each of these variables and sale price per acre with the signs of the actual correlations for our sample indicates few consistencies (Table 5). Although we hypothesized that environmental attractiveness should b[illegible] a positive relationship

[1]Ratings were adjusted for the systematic tendency of some observers to list more things than others.

to land value, the majority of the correlations indicate a negative association. Only average height of ground cover, percent of land in open space, and average number of items observed have the expected sign for the entire sample and for one of the sub-samples. Only one of these correlations --- that involving average height of ground cover for small parcels --- is significant at the 0.05 level.

In general, the level of significance of the coefficients is very low. The only coefficients significant at the 0.05 level for all transactions as a whole are those involving average girth of trees and the average attractiveness rating, and as was indicated above, these signs are in the opposite direction from that hypothesized. Because of the generally low significance levels of the environmental attractiveness variables, regression equations including them are not reported here. Suffice it to say that the only two such variables to enter the regression equations were: average number of items observed in the equation for large parcels, and average attractiveness rating in the equation for all parcels. Each of these appeared with a negative sign, indicating that the more attractive a parcel is, the cheaper it is.

We hesitate to draw any firm conclusions from our attempt to define and analyze variables describing environmental attractiveness, because of the small size of the sample of transactions. Our conclusions, also, are limited by the range of variation in environmental attractiveness of the parcels in the sample, all of which are relatively attractive. Had our sample included parcels of breathtaking beauty or extreme ugliness, it is likely that the environmental variables would have been of greater statistical significance. However, our results are consistent with the apparently contradictory notion that land which is more scenic or atrractive tends to be cheaper than land which is less attractive. Specifically, they suggest that a parcel which has large trees, or a large percent of its area in open space, or receives a high attractiveness rating is likely to sell at a lower price than other land.

Of these characteristics, the presence of large trees may add to the difficulty of development. The analysis in the earlier part of this paper also indicated that certain characteristics which suggest environmental attractiveness also suggest difficulty or expense of development and therefore are associated with lower prices per acre. As examples are the variables:

percent of parcel wooded, topographic roughness of land, and existence of a stream on the parcel. Therefore, the two parts of this paper indicate that environmental attractiveness, as we have defined it based upon our related research, has a negative association with land price. This association is not to be explained by saying that people do not like attractive land, but that they are more concerned with the fact that attractive land is generally more difficult or expensive to develop than flatter, less wooded land which is free of watercourses.

These findings must be regarded as tentative even for the Upper East Branch Brandywine Basin. Their application to other rural-urban fringe areas should be made with care. They should not be applied to other situations, such as areas of heavy urban or suburban development, to resort areas or to areas of unusual scenic quality.

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